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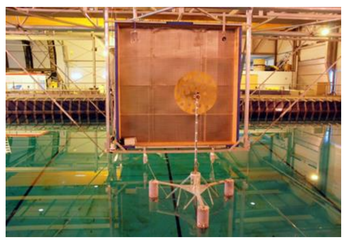
SoftWind project

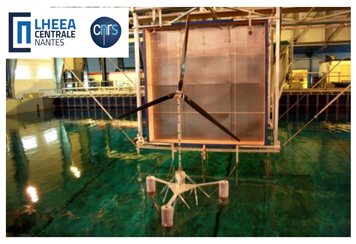
LHEEA CENTRALE NANTES — cnrs — D-ICE ENGINEERING — WEST ATLANTIC MARINE ENERGY CENTER

SoftWind is a 3-year project that aims at developing an experimental setup dedicated to the model testing of floating wind turbines in a wave tank. The experimental modelling methodology is based on an Software-In-the-Loop (SIL) approach that combines numerical modelling with experimental modelling.

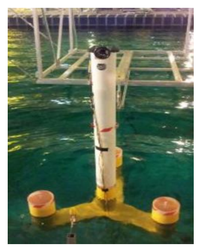
Aerodynamic Thrust Modelling for Wave Tank Tests of FOWT

	Thrust force	Dynamical loads	Rotor control/ command testing	Upscaling capability (P_{Rotor}> 5MW)
Froude-scaled « thrust » with drag disk	+ +	- -	- -	-
Froude-scaled thrust geometry (Froude scaling)	+	-	-	-
Rotor performance scaled (Low Reynolds number airfoils)	++	-+	-	-
SIL	++	+/++	++	++


Drag disk

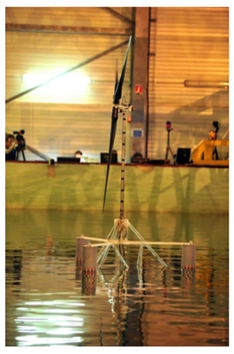

Strictly Froude-scaled model

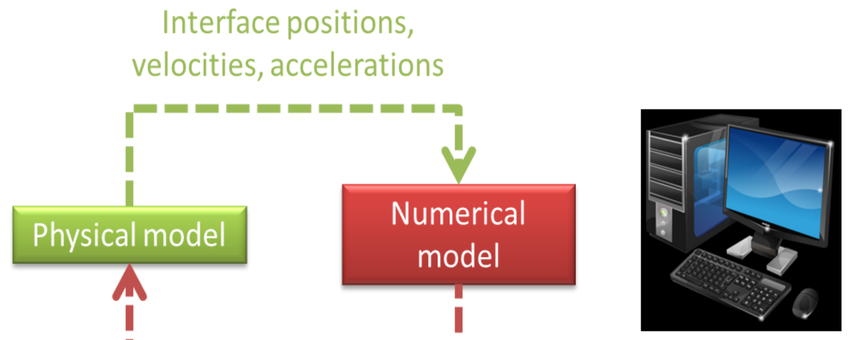

Low Re number airfoils


SIL approach

Basic Principle of SIL Methodology for Wave Tank Tests of FOWT

- The rotor is represented by an actuator placed at the top of the tower. The actuator is in charge of emulating the response of the rotor.
- The aerodynamic forces are simulated numerically and are communicated to the actuator. The actuator applies the forces to the model.
- The motion of the model is affected by the actuator forces.
- In response sensors placed on the model inform the numerical model on the nacelle position and speed.



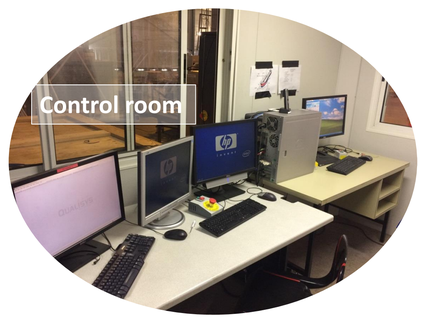


SOFTWIND Current Experimental Setup

A test bench with a single actuator is currently tested. The purpose of this set up is the validation of :

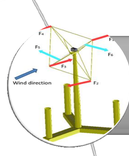
- the communication protocols,
- the real-time execution of the numerical model,
- the motion and force observers,
- the preliminary actuator model identification.

Preliminary validation tests consist in imposed motions by means of a hexapod and will be followed by wave tank tests next September.



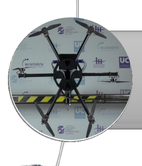
Actuators used in SIL Approaches dedicated to FOWT

CENER
- 1 ducted fan on-board

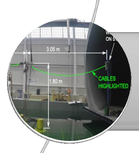


SINTEF
- 6 force-controlled wires with winch units

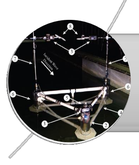
MARIN
- 6 force-controlled wires with winch units



IH Cantabria
- 6 on-board fans on a frame



Umaine
- 2 force-controlled wires with winch units



UC Berkeley
- 2 fans on rotating masts

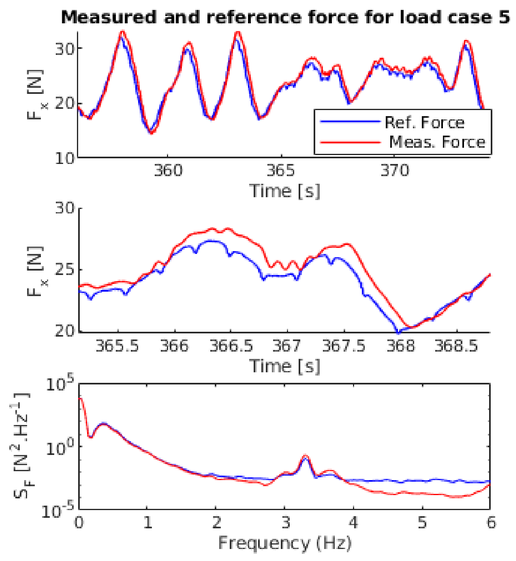
- Performance Assessment

- List of wind and waves load cases

	H_s [m]	T_p [s]	U_w [m/s]	Mean thrust [kN]
LC1	3	5	11.4	680
LC2	4	5	18	320
LC3	6	10	11.4	680
LC4	7	10	18	320
LC5	7	17	11.4	680
LC6	8	17	18	320

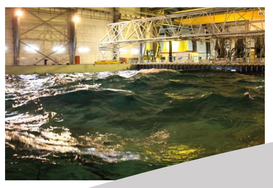
- Relative error on the thrust force for the 6 load cases

Load Case	LC1	LC2	LC3	LC4	LC5	LC6
Mean Thrust (N)	25	12.5	25	12	24	12
Error (%)	3	5	5	10	4	5



➔ In parallel, there are ongoing works focusing on the design of an advanced emulator composed by multiple actuators (fans).

Key milestones of the project



October 2017: Kick-Off

2018

Test with imposed motions and 1 DOF emulator

2019

1st Wave tank test with 1 DOF emulator

2019

2nd experimental test with imposed motions and advanced emulator

2020

2nd Wave tank tests with advanced emulator

October 2020: End of the project